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Issued July 11, 1907.

U. S. DEPARTMENT OF AGRICULTURE,
FOREST SERVICE—Circular 104.
GIFFORD PINCHOT, Forester.

BRUSH AND TANK POLE TREATMENTS.

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GOVERNMENT PRINTING OFFICE : WASHINGTON : 1907

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BRUSH AND TANK POLE TREATMENTS.

INTRODUCTION.

The preservative treatment of railroad ties and piling has been practiced commercially for a number of years. About fifty treating plants are now being operated in this country, and the number increases each year. The treatment of telephone and telegraph poles has made no such progress, yet there is a strong desire on the part of progressive users to find a satisfactory method for prolonging the life of poles. From time to time experiments have been conducted by various telephone, telegraph, and railroad companies, but either the treatment was faulty or insufficient records of the treated poles were kept, and, as a result, neither reliable data nor satisfactory conclusions have been obtained.

In some cases the whole length of the pole has been treated in closed cylinders, but this expensive treatment is used only on poles to be set where the top as well as the part in the ground is subject to rapid decay. Often preservatives have been applied to the butt of poles with a brush, and when the poles were seasoned doubtless much good was accomplished. But when the oil had been applied to the outside of green, freshly cut poles they were found to decay practically as soon as untreated poles. Thereupon the preservative was declared valueless, and the experiment considered as proof that poles could not be satisfactorily treated by that method.

Consumers of poles are generally of the opinion that present conditions do not warrant a very large outlay for treatment; nevertheless, because of the diminishing supply, they demand that the length of service be increased. That seasoned wood is more durable than green in contact with the ground is generally admitted, but how much more is not known. Many also hold that wood which has been soaked in water is more durable than that which has not been soaked, but here again definite proof is lacking. For these reasons the Forest Service has undertaken to determine what treatments are most effective and what expense for treatment is justified by the resulting increased service.

Circular 103 presented the results of experiments to determine the rate of seasoning of telephone poles. Mention was there made of a series of experiments to determine the effect of various preservative treatments in delaying their decay. The present circular describes the experimental treatments of these seasoned poles by the brush and by the open-tank methods. The latter is a new method developed by the Forest Service and promises excellent results in treating poles cheaply and effectively.

PLAN OF THE EXPERIMENTS.

The experiments were planned not only to afford data on the relative increase of life of treated over untreated timber, and on the value of different preservatives, but also to determine the effect upon the durability of poles of air seasoning, and of soaking in water with subsequent air seasoning.

The large question to be answered is, What is the best method of increasing the length of service of poles? This question, however, is very complicated and its answer can only be arrived at by answering a number of other more simple questions upon which it depends. The questions which these experiments are designed to answer are as follows:

1. What advantages have seasoned over unseasoned poles in taking treatment?
2. What is the increase in length of service of seasoned over green poles, both when untreated and treated?
3. Does submersion in water, with subsequent air seasoning, render poles more durable or easier of treatment than simple air seasoning?
4. Does the season of cutting affect treatment?
5. What preservatives are easiest of application and most effective?
6. What method of application is best?

Of these questions, 2, 3, 5, and 6 can be answered, in whole or in part, only after the lasting qualities of the poles have been tested in actual use. This test has already been begun by setting the poles in an experimental line; but some years must elapse before results will be obtainable. The present circular presents the information gathered in the course of administering the treatment, and throws light on the capacity of poles—green, seasoned, and soaked—to absorb preservatives, the degree of penetration secured with different preservatives, and the comparative cost of treatment by the brush and the open-tank methods.

To show what has been done to arrive at final conclusions as to the comparative effects upon durability of the different preservatives and different methods of handling and treating, there is appended a description of the experimental lines in which the poles have been set.

Seven preservatives were used in the experiments. All of these are regularly sold on the market for preserving wood and most of them are protected by patent or trade-mark. All the preservatives are more or less modified distillates of coal tar or pine tar. Except for the preservative designated (D), which is common creosote or dead oil of coal tar, the names of the different preservatives are not given, but their composition is given in Appendix I. With one or two exceptions, the unnamed preservatives were given by the manufacturers for use in these experiments.

METHODS OF TREATMENT.

Two methods were employed in applying the preservative to the poles. On the larger number of poles the preservative was applied to the outside with a brush, allowing it to soak into the wood through its own power of penetration. All the different preservatives were tested by this method. The second method was to soak the butts of the poles in hot preservative in an open tank. In this method only one preservative, the dead oil of coal tar (D), was used.

BRUSH TREATMENT.

It is generally conceded that the portion of a pole most subject to decay is that between 2 and 8 feet from the butt—about 20 square feet. This part fails when the remainder is still in a good state of preservation. It was therefore selected for treatment. When the pole is set the treated portion extends 2 feet above and 4 feet below the surface of the ground. From one to three coats were applied, according to directions received from the manufacturer. Most of the preservatives were heated to a temperature of from 150° to 175° F. Particular attention was paid to filling all checks and knot holes and to working the preservative into the wood, thus protecting against decay those parts most subject to attack. Careful notes were made of the condition of the poles as regards checks, knot holes, etc. The amount of preservative absorbed by each pole was accurately determined by recording the weight of the preservative before and after each treatment. The temperature of the preservative both before and after the treatment was also noted and recorded. In addition holes were bored into different parts of the treated portions of the poles, and the depth to which the preservative penetrated was closely observed.

OPEN-TANK TREATMENT.

The device for the open-tank process consisted of a steel tank resting on stone or brick walls in such a manner that a fire could be placed beneath it. The top of the tank was rectangular in shape, about 11 feet long and 6 feet wide. Its depth was about 4 feet at one end, tapering gradually to zero at the other. A vertical cross section of the length of the tank presented a right-angled triangle about 4 by 11 by 12 feet, the bottom of the tank forming the hypotenuse of the triangle (fig. 1). The butt ends of four poles were placed in the tank so that they lay at an angle of about

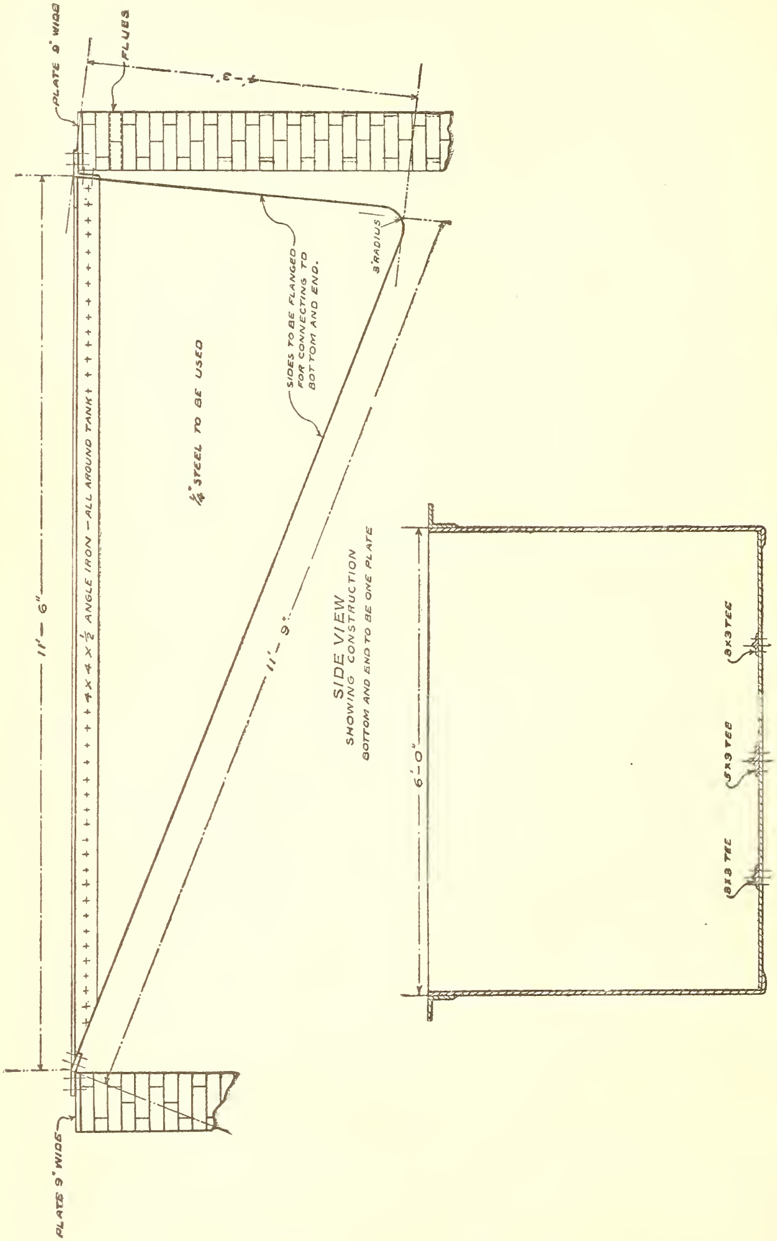

Fig. 1.—Working drawing of open tank. (Lower diagram shows strengthening tees on bottom of tank.)

20°, the tops of the poles resting on props. Creosote was poured into the tank until the poles were covered for a distance of about 8 feet from the butt, and was then heated to a temperature above the boiling point of water. This temperature was maintained until the air in the wood had been expanded and the water in the outer layers vaporized, and both, so far as possible, driven out. The theory of this process is more fully discussed in Circular 101, Forest Service. The preservative was then allowed to cool, thus producing a partial vacuum by the contraction of the air and the condensation of the steam remaining in the wood. The poles remained in the cooling liquid while the preservative, under atmospheric pressure, was forced into the wood. The entire time consumed by each treatment was about twenty-four hours, during which the temperature of the preservative was above the boiling point of water for eight or nine hours.

Open-tank treatment was given to 160 seasoned and 24 green chestnut poles at Dover, N. J., and Thorndale, Pa. Each pole was weighed before being put into the tank and again immediately upon being taken out. In this manner the amount of preservative absorbed was determined. No account could be taken of the amount of moisture driven out of the wood during the time the preservative was heated above the boiling point of water, and therefore the amount actually absorbed may be slightly greater than appeared from the weights. However, since the seasoned poles were practically air dry the determinations are probably very nearly correct. In the case of the green poles, on the other hand, it is probable that the actual absorption was considerably greater than that shown.

CALCULATING THE COST OF TREATMENT.

During the treatments an effort was made to determine the itemized cost of treating the average pole, but many factors which would not be present in treatments on a commercial scale entered into the experiment and vitiated the results. In order, therefore, that the cost of the several treatments might be readily compared a constant labor charge and miscellaneous cost have been used.

For brush treatments it has been assumed that 6 men in two days can treat 100 poles with two coats of preservative at a cost of $22. The items making this cost are: Four men, at $1.75 per day for two days, $14; 2 men, at $1.50 per day for two days, $6; and miscellaneous expenses, including fuel and wear and tear of apparatus, $2. To the above cost of 22 cents per pole must be added the cost of the preservative absorbed by the average pole. This amount varies with the preservative and the locality.

For tank treatments it has been assumed that 6 men and 1 team of two horses can handle and treat 50 poles per day at a cost of $22.50.

The items in this cost are: Six men, at $1.75 per day, $10.50; 1 team, at $4.50 per day, $4.50; 1½ cords of fuel, $5; and miscellaneous expenses, including wear and tear of apparatus, $2.50. To the above cost of 45 cents per pole must be added the cost of the preservative absorbed by the average pole.

RESULTS.

QUANTITY OF PRESERVATIVES ABSORBED.

Tables 1 and 2 give in detail the absorption of the several preservatives and the average cost per pole with the brush treatment—Table 1 for cedar poles at Wilmington, N. C., and Table 2 for chestnut poles at Pisgah, N. C., Dover, N. J., and Thorndale, Pa. Table 3 shows the average absorption and cost of treatment of chestnut poles at Dover and Thorndale by the open-tank method.

TABLE 1.—*Brush-treated cedar poles at Wilmington, N. C.*

Preservative.[a]	Poles treated.	Coats applied.	Absorption per pole.			Average cost per pole.	Relative rank in order of cheapness.
			Average.	Maximum.	Minimum.		
	Number.	*Number.*	*Pounds.*	*Pounds.*	*Pounds.*	*Cents.*	
A	24	2	3.59	4.75	2.63	46.9	7
B	21	2	3.65	5.25	2.75	41.3	5
B	3	1	1.63	1.63	1.63	19.6	....
C	20	[b] 3	4.73	5.51	4.13	46.8	6
C	4	[c] 3	4.75	5.25	4.13	46.8	....
D	34	2	4.91	6.37	3.25	26.6	2
D	14	3	7.05	8.00	5.63	39.6	....
E	24	2	4.37	5.25	3.38	28.6	3
F	24	2	6.04	7.38	4.50	32.8	4
G	12	1	7.00	....	....	20.0	1

[a] For analyses and manufacturers' directions for applying the various preservatives see Appendix I.

[b] Cold.

[c] Hot.

TABLE 2.—*Brush-treated chestnut poles at Pisgah, N. C., Dover, N. J., and Thorndale, Pa.*

Preservative.	Poles treated.	Coats applied.	Absorption per pole.			Average cost per pole.	Relative rank in order of cheapness.
			Average.	Maximum.	Minimum.		
	Number.	*Number.*	*Pounds.*	*Pounds.*	*Pounds.*	*Cents.*	
A	86	2	4.48	6.63	2.50	53.1	6
A	12	1	2.59	4.62	1.62	28.9	....
B	86	2	4.36	6.63	3.01	45.0	4
B	10	1	3.48	5.13	1.35	29.4	....
C	24	3	6.69	9.00	4.88	52.5	5
D	120	2	7.53	11.75	4.13	29.0	2
D	6	3	6.46	8.26	3.75	39.0	....
D	2	1	5.06	5.50	4.62	15.7	....
E	76	2	5.45	7.00	3.25	30.2	3
E	22	1	2.44	3.63	1.75	14.7	....
F	88	2	7.30	10.87	4.50	35.1	4
F	16	1	3.39	4.13	2.88	17.1	....
G	36	1	7.00	....	....	20.0	1

One hundred and eighty-four chestnut poles were treated in open tanks at Dover, N. J., and Thorndale, Pa. Of these, 160 were seasoned and 24 green. Table 3 gives the total number and the average absorption and cost of treatment per pole in each season's cut of seasoned and green poles.

TABLE 3.—*Tank-treated chestnut poles at Dover, N. J., and Thorndale, Pa.*

SEASONED POLES.

Season cut.	Poles treated.	Average absorption.	Cost of treatment.
	Number.	*Pounds.*	*Cents.*
Spring	28	26.6	69.7
Summer	81	23.2	66.6
Autumn	43	18.0	61.7
Winter	8	25.0	68.3
Total	160		

GREEN POLES.

Season cut.	Poles treated.	Average absorption.	Cost of treatment.
Summer	24	13	37.1

There was a wide variation in the amount absorbed, as may be seen from the maximum and minimum runs of the spring, summer, and autumn cuts.

Table 4 shows the maximum and minimum runs of the spring, summer, and autumn cuts. Only two runs of winter-cut poles were included in the tank treatments, and this season's cuts are therefore not given.

TABLE 4.—*Absorption of each pole in maximum and minimum runs on spring, summer, and autumn cut chestnut poles.*

SPRING CUT.

Maximum.		Minimum.	
Pole No.	Absorption.	Pole No.	Absorption.
	Pounds.		*Pounds.*
1	32	1	22
2	25	2	23
3	41	3	21
4	26	4	16
Average	31	Average	20.5

SUMMER CUT.

Pole No.	Absorption.	Pole No.	Absorption.
1	35	1	10
2	35	2	13
3	38	3	9
4	36	4	17
Average	36	Average	12.25

AUTUMN CUT.

Pole No.	Absorption.	Pole No.	Absorption.
1	28	1	9
2	32	2	12
3	28	3	8
4	35	4	10
Average	30.75	Average	9.5

The maximum absorption by any one seasoned pole was 44 pounds and the minimum 8 pounds. The maximum absorption by any one green pole was 18 pounds and the minimum 4 pounds.

Although it appears from Table 3 that spring-cut poles absorbed more preservative than any other season's cut, it is hardly safe to accept it as a general fact, because of the small number of poles used in the experiments and the variation between the individual runs. However, the increased absorption of the spring-cut poles agrees with the results of the seasoning experiments set forth in Circular 103, which showed spring-cut poles at all stages to have contained less water than poles cut at other seasons.

Experiments are now being carried on by the Forest Service to determine with certainty the relation of season cut to absorption.

ABSORPTION INCREASED BY SEASONING.

It was found that the more thoroughly the pole is seasoned the deeper and more uniform is the penetration and the greater is the absorption. This seems to be equally true in both brush and tank treatments. From page 11 it will be seen that the seasoned poles absorbed nearly twice as much preservative as the green poles.

ABSORPTION UNAFFECTED BY SOAKING.

In this series of experiments the only opportunity to study the effect of water-soaking on the absorption of the preservatives was at Wilmington, N. C., where all of the preservatives were applied by the brush method.

Here it was impossible to note any difference in absorption or penetration on poles which had been soaked over those which had not. Other experiments of the Forest Service where different methods of treatment have been tried bear out this same conclusion.

EFFECT OF SEASON OF CUTTING ON ABSORPTION.

In the brush treatments it was impossible to note any characteristic difference in absorption or penetration due to the season of cutting. In the tank treatments, where only one preservative was used, the difference seems to be quite marked. The spring-cut poles absorbed the most, and the cuts of winter, summer, and autumn follow in the order given. This agrees with Circular 103, which shows the spring and winter cut poles to lead in the progress of seasoning.

EASE OF APPLICATION.

Brush treatment.—Those preservatives which solidify at low temperatures are least easy to apply. This is especially true when the treatment is made in cold weather. The low atmospheric temperature will cause the preservative to solidify when it strikes the pole and thus prevent a good penetration. The second coat, although applied hot, often fails to melt the first and penetrate the pole, but remains on the outside to be scraped off or melted off at the first rise of temperature.

Open-tank treatment.—The effect of air temperature upon the preservative is less important when the open-tank process is used. In this case the preservative in contact with the pole is kept liquid by heat. As only one preservative was used in this process, no opportunity was given for comparison. Yet from other experiments it might be stated that in general the thinner the solution the easier is its application, provided a temperature above the boiling point of water can be maintained without the loss of the preservative by evaporation.

METHOD OF APPLICATION.

Brush treatment.—In most cases a better penetration is secured by applying the preservative hot than cold. The degree of temperature necessary depends largely upon the extent to which the wood is seasoned. In well-seasoned wood all that is required is that the preservative be thoroughly liquid. In partially seasoned or unseasoned wood a higher temperature is essential to secure the best penetration. In most cases a temperature above 200° F. is inadvisable; this is especially true when the preservatives employed contain oils having a low boiling point, since such oils evaporate very readily upon being spread over the pole.

Open-tank treatment.—In this process, where it is necessary to hold the temperature above the boiling point of water for several hours, it is advisable to use a preservative containing few or none of the light oils, since liquids which by the usual method of analysis distill off but a very small per cent below 400° F. have decreased very considerably by evaporation when held between 212° and 275° for several hours. When the temperature was raised above 275° the outer portions of the poles were more or less scorched.

DEPTH OF PENETRATION SECURED.

Brush treatment.—A penetration of from two to three annual rings, ranging from one-sixteenth to one-fourth of an inch, was secured. The penetration seemed to be slightly greater in chestnut than in cedar.

Open-tank treatment.—The average penetration by this process was about one-half inch. In open-grained, porous wood, and in that which was slightly doty or defective, it was somewhat greater, reaching a maximum of from three-fourths of an inch to 1 inch, while in close-grained, dense wood the penetration was from one-fourth to one-half of an inch.

PROBABILITY THAT TREATMENT WILL PAY.

Though the length of time added to the service of these poles can not now be stated, enough is known regarding the value of the preservatives as preventives of decay to justify a conclusion as to whether the added life will repay the cost of treatment.

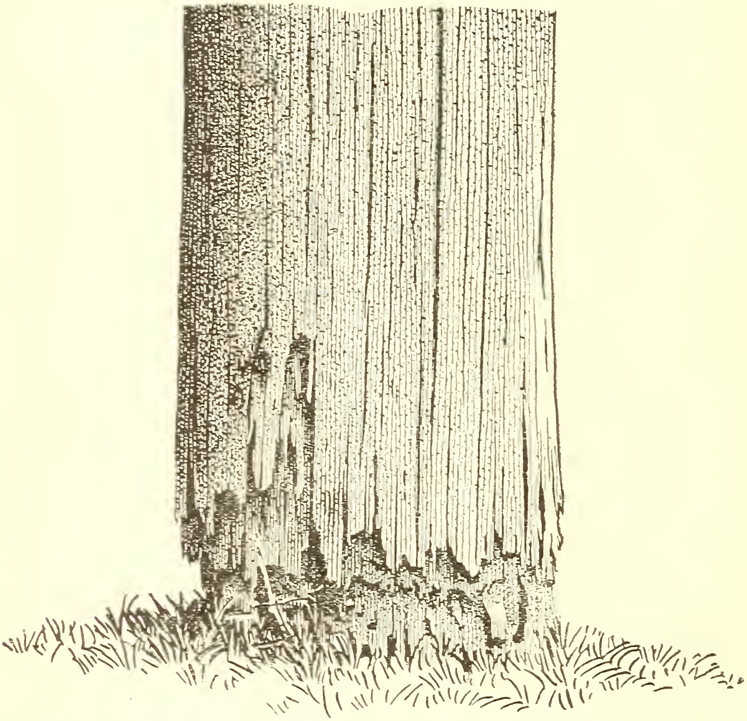

FIG. 2.—Untreated chestnut pole, showing decay at ground line after six years' service. (Drawn from a photograph.)

By the brush method the average cost per pole was about 40 cents, or 29 cents in the case of creosote, of which 7 cents stands for the cost of oil. By the open-tank process the average cost per pole with creosote (the only preservative used) was 67 cents, of which 22 cents stands for the cost of oil.

Assuming that the cost of a standard 30-foot pole at the setting hole is $8, and that, untreated, it will last twelve years, the added life necessary to repay the cost of treatment with creosote by the brush method will be about six months and by the open-tank method about one year. A very conservative estimate of the added life by the brush method is thought to be three years, which would mean a great saving. In the tank treatment three times as much oil was absorbed as in the brush treatment, and the penetration was at least three times as great. If it results in prolonging the life of the pole in proportion to the oil absorbed, then it will be a very efficient treatment, and the economy of its use will be very great, not only in comparison with no treatment, but in comparison with the brush treatment. The manner in which preservative treatment serves to prolong the life of a pole is strikingly shown by figs. 2 and 3.

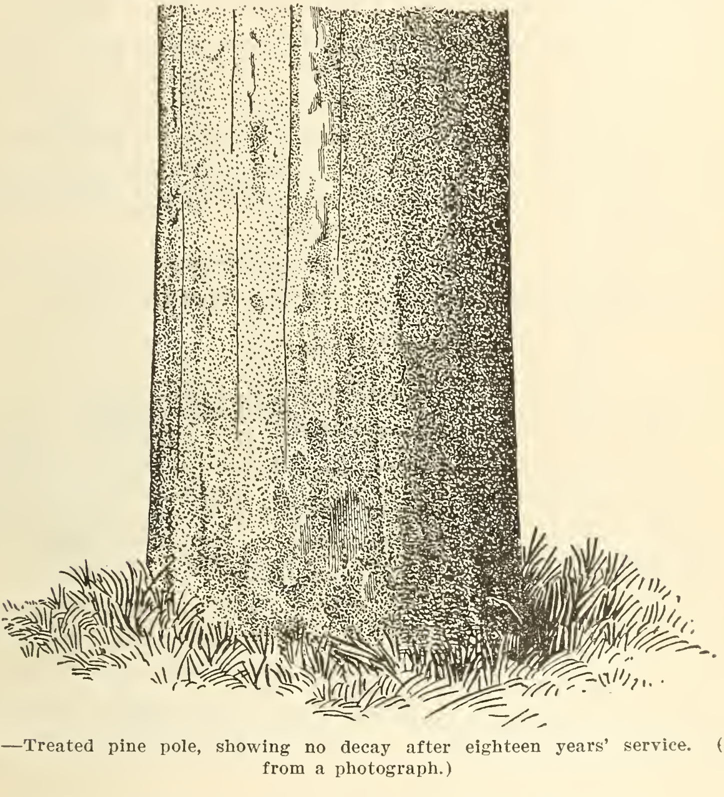

FIG. 3.—Treated pine pole, showing no decay after eighteen years' service. (Drawn from a photograph.)

APPENDIX I.

PRESERVATIVES USED.

The various preservatives are designated by letters. The greater part of the treatments were made in accordance with directions or advice given by the manufacturers of the preservatives. In instances where the treatment varied from the directions note is made of such variation. Analyses of some of the preservatives made by the manufacturers were submitted to the Forest Service, and, in addition, analyses of practically all the preservatives used were made by the engineering department of the American Telephone and Telegraph Company. Both sets of analyses are given exactly as received. It should be understood that the Forest Service is in no way responsible for the methods used or the results obtained.

Detailed descriptions of the various preservatives, together with the general instructions of manufacturers for their use, follow:

PRESERVATIVE "A."

Manufacturer's analysis.	
Color	Red-brown.
Specific gravity at 21° C.	1.126.
Viscosity at 21° C	115.860.
Mineral matter (ash)	0.047 per cent.
Flashing point	127° C.
Burning point	179° C.
Distillates:	
From 220° C. to 260° C.	4.5 per cent.
From 260° C. to 274° C.	1.0 per cent.
From 274° C. to 302° C.	20.0 per cent.
Naphthalene	Very slight trace.
Mineral acids (HCl, H_2SO_4).	Very slight trace.
Phenols	Very slight trace.

Analysis of engineering department American Telephone and Telegraph Company.		
	Series I.	Series II.
Color	Red-brown	Red-brown.
Specific gravity at 17° C.	1.121	1.122.
Mineral matter	0.160 per cent	0.050 per cent.
Flashing point	137° C	137° C.
Burning point	164° C	168° C.
Distillates:		
Below 235° C	0.41 per cent	0.61 per cent.
Loss	0.19 per cent	0.22 per cent.
From 235° C. to 315° C.	19.16 per cent	26.97 per cent.
Residue above 315° C.	70.24 per cent	72.20 per cent.
Solids, 1.7° C. to 4.4° C.	No separation	No separation.
Tar acids	1.12 per cent	1.16 per cent.

Manufacturers' directions for applying Preservative "A."

In hot weather when the temperature reaches as high as 75° in the shade we would recommend the application in its natural state. In winter we would recommend the preservative to be heated in an iron vessel to about 150°, or even 250° if necessary, and apply it with a brush like paint. When it is possible to dip the parts into the liquid, the impregnation is much stronger. The second coat should not be applied until the first is dry.

PRESERVATIVE "B."

(No analysis received from manufacturer.)

Analysis of engineering department American Telephone and Telegraph Company.

	Series I.	Series II.
Color	Red-brown	Red-brown.
Specific gravity at 17° C	1.134	1.134.
Flashing point	135° C	135° C.
Burning point	163° C	162° C.
Distillates:		
Below 235° C	0.35 per cent	0.31 per cent.
Loss	0.13 per cent	0.19 per cent.
From 235° C. to 315° C	28.84 per cent	30.10 per cent.
Residue over 315° C	70.68 per cent	69.40 per cent.
Solids 1.7° C. to 4.4° C	No separation	No separation.
Tar acids	1.30 per cent	1.30 per cent.
Mineral matter	0.31 per cent	0.47 per cent.

Manufacturer's directions for applying Preservative "B."

Two coats of preservative heated to about 150° F. to be applied with brushes. The second coat to be put on when the first is dry.

PRESERVATIVE "C."

Manufacturer's analysis.		Analyses of engineering department American Telephone and Telegraph Company.		
			Series I.	Series II.
Color	Green-black.	Color	Green-black	Green-black.
Specific gravity	1.03.	Specific gravity at 17° C	1.032	1.031.
Flashing point	78° C.	Flashing point	90° C	90° C.
Burning point	93° C.	Burning point	99° C	101° C.
Distillates:		Distillates:		
Below 315° C	37.40 per cent.	Below 235° C	15.14 per cent	14.97 per cent.
Above 315° C	52.69 per cent.	Loss	0.65 per cent	0.53 per cent.
Coke and gas corresponding to.	9.91 per cent.	From 235° to 315° C	26.23 per cent	25.60 per cent.
		Residue above 315° C	57.98 per cent	58.90 per cent.
		Solids, 1.7° to 4.4° C	No separation	No separation.
		Tar acids	15.40 per cent	16.30 per cent.
		Mineral matter	0.14 per cent	0.02 per cent.

Manufacturer's directions for applying Preservative "C."

Three coats of cold (unheated) preservative, each successive coat to be applied after the previous one has dried.

PRESERVATIVE "D."

Sample 1.

Manufacturer's analysis.	
Color	Greenish-brown.
Distillates:	
Below 210° C	2.4 per cent.
From 210° to 235° C.	46.9 per cent.
From 235° to 315° C.	36.3 per cent.
From 315° to 345° C.	9.3 per cent.
Residue in retort	4.8 per cent.
Loss	0.3 per cent.
Total	100.0 per cent.
Tar acids	9.25 per cent.
Crude crystallizable naphthaline.	28.60 per cent.

Analyses of engieeering department American Telephone and Telegraph Company.	Series I.	Series II.
Color	Greenish-brown.	Greenish-brown.
Specific gravity at 38° C.	1.035	1.035.
Distillates:		
Below 170° C	0.17 per cent.	0.09 per cent.
From 170° to 205° C.	1.25 per cent.	0.70 per cent.
From 205° to 210° C.	1.14 per cent.	0.74 per cent.
From 210° to 235° C.	43.96 per cent.	45.92 per cent.
From 235° to 240° C.	6.66 per cent.	6.12 per cent.
From 240° to 270° C.	19.48 per cent.	20.03 per cent.
From 270° to 300° C.	10.07 per cent.	9 61 per cent.
Residue above 300° C.	17.00 per cent.	16.30 per cent.
Loss	0.27 per cent.	0.49 per cent.
Total	100.00 per cent.	100.00 per cent.
Naphthalene	45.10 per cent.	46.66 per cent.
Liquid at	38° C.	38° C.
Tar acids	9 c. c.	8.3 c. c.

No specific directions for applying this preservative were received from the manufacturer; it was understood, however, that it was to be applied hot.

Sample 2.

Manufacturer's analysis.	
Color	Greenish-brown.
Specific gravity at 44.4° C	1.027.
Specific gravity at 15.5° C	1.044.
Distillates:[a]	
Below 170° C	Trace.
From 170° C. to 200° C	2.1 per cent.
From 200° C. to 205° C	3.4 per cent.
From 205° C. to 210° C	6.7 per cent.
From 210° C. to 235° C	45.9 per cent.
From 235° C. to 240° C	50.1 per cent.
From 240° C. to 270° C	69.7 per cent.
From 270° C. to 300° C	80.2 per cent.
From 300° C. to 315° C	82.7 per cent.
Residue at 315° C	14.00 per cent.
Dry naphthalene at 15.5° C	24.2 per cent.
Naphthalene (by creosoter's test)	42.5 per cent.
Liquid at	36° C.
Tar acids	4 per cent.

Analysis of engineering department American Telephone and Telegraph Company.	
Color	Greenish-brown.
Specific gravity at 38° C	1.018.
Distillates:	
Below 170° C	0.09 per cent.
From 170° C. to 205° C	1.00 per cent.
From 205° C. to 210° C	1.19 per cent.
From 210° C. to 235° C	34.99 per cent.
From 235° C. to 240° C	7.57 per cent.
From 240° C. to 270° C	23.48 per cent.
From 270° C. to 300° C	11.50 per cent.
Loss	0.40 per cent.
Residue above 300° C	19.78 per cent.
Total	100.00 per cent.
Naphthalene	36.18 per cent.
Liquid at	38° C.
Tar acids	4.8 c. c.

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[a] The per cents between the several degrees of temperature have been added to the total of those preceding. For example: The per cent coming over between 205° and 210° C. is 3.3, and the total up to 210° C. is 6.7.

No specific directions for applying this preservative were received from the manufacturer. It was understood, however, that it was to be applied hot.

Sample 3.

(No analysis by engineering department American Telephone and Telegraph Company.)

Manufacturer's analysis.

Color	Greenish-brown.
Specific gravity at 15.5° C	1.042.
Distillates:[a]	
Below 170° C	0.0 per cent.
From 170° C. to 200° C	2.8 per cent.
From 200° C. to 205° C	4.5 per cent.
From 205° C. to 210° C	8.1 per cent.
From 210° C. to 235° C	34.5 per cent.
From 235° C. to 240° C	40.5 per cent.
From 240° C. to 270° C	63.1 per cent.
From 270° C. to 300° C	74.1 per cent.
From 300° C. to 315° C	78.8 per cent.
Residue at 315° C	17.0 per cent.
Dry naphthalene	0.0 per cent.
Naphthalene (by creosoter's test)	28.2 per cent.
Liquid at	Below 0° C.
Tar acids	4.5 per cent.

[a] See foot note on page 18.

No specific directions for applying this preservative were received from the manufacturer. It was understood, however, that it was to be applied hot.

PRESERVATIVE " E."

(No analysis received from manufacturer.)

Analyses of engineering department, American Telephone and Telegraph Company.

	Series I.	Series II.
Color	Greenish-black	Greenish-black.
Specific gravity at 17° C	1.035.	1.035.
Flashing point	115° C.	111° C.
Burning point	129° C.	123° C.
Distillates:		
Below 235° C	2.51 per cent	3.65 per cent.
Loss	0.29 per cent	0.51 per cent.
From 235° C. to 315° C	26.00 per cent	24.74 per cent.
Residue at 315° C	71.20 per cent	71.10 per cent.
Solids 1.7° C. to 4.4° C	No separation	No separation.
Tar acids	13.70 per cent	11.80 per cent.
Mineral matter	0.04 per cent	0.00 per cent.

No specific directions for applying this preservative were received from the manufacturer. It was understood, however, that it was to be applied hot.

PRESERVATIVE "F."

(No analysis received from manufacturer.)

Analyses of engineering department, American Telephone and Telegraph Company.

	Series I.	Series II.
Color	Light brown	Light brown.
Specific gravity at 38° C	1.007	1.005.
Distillates:		
Below 170° C	26.66 per cent	96.90 per cent.
From 170° C. to 205° C	17.39 per cent	0.10 per cent.
From 205° C. to 210° C	9.27 per cent	0.00 per cent.
From 210° C. to 235° C	25.92 per cent	0.00 per cent.
From 235° C. to 240° C From 240° C. to 270° C From 270° C. to 300° C	15.98 per cent	0.15 per cent.
Above 300° C	4.24 per cent	0.85 per cent.
Loss	0.54 per cent	2.00 per cent.
Total	100.00 per cent	100.00 per cent.
Naphthalene	35.19 per cent	None.
Water	20.00 per cent	90.00 per cent.
Tar acids	19 c. c.	1 c. c.
Note	Sticks and other foreign matter present.	Sticks, sand, and other foreign matter present.

No specific directions for applying this preservative were received from the manufacturer. It was understood, however, that it was to be applied hot.

PRESERVATIVE "G."

This was ordinary coal tar which was heated to about 180° F. before being applied to the poles.

No analysis was made.

Table 1 gives the cost and weight in pounds per gallon of each preservative. With one exception, the weight is calculated from the specific gravity determined by the engineering department of the American Telephone and Telegraph Company.

TABLE 1.—*Cost and weight of each preservative.*

Preservative.	Cost per gallon.	Weight per gallon.
	Cents.	*Pounds.*
A	65	9.37
B	50	9.45
C	25	8.59
D (Sample 1)	8	8.62
D (Sample 2)	8	[a] 8.70
D (Sample 3)	8	8.68
E	13	8.63
F	25	8.37
G	12	9.41

[a] Calculated from specific gravity given by manufacturer.

APPENDIX II.

Since the general practice in telephone and telegraph line building is to set green or partially seasoned poles, it was decided to take green poles as the basis of comparison. In the experimental lines every treated pole stands between a green pole and an untreated seasoned pole. Comparison is therefore possible between the green poles and all other classes.

The following setting plans show the relative position of the treated, seasoned, and green poles set in the two experimental telephone lines:

SAVANNAH-ABBEVILLE-EASTMAN TOLL LINE.

Arrangements were made with the Southern Bell Telephone and Telegraph Company to set 300 cedar and 300 chestnut poles, treated and untreated, which had been air-seasoned at Wilmington and Pisgah, N. C., and also a number of green cedar and chestnut poles in a portion of the Savannah-Abbeville-Eastman Toll Line in Georgia. This section of the country was selected primarily because of the rapidity with which timber decays in it, thus insuring results in the shortest possible time.

The line starts at the northern limits of the city of Savannah, and runs about 20 miles in a northerly direction. It contains 816 poles, of which the first half are cedar and the remainder chestnut. Fifty per cent of each kind were treated, and 50 per cent were left untreated. Of the treated poles, 94.1 per cent were air-seasoned before treatment and 5.9 per cent were green. Of the untreated poles 53 per cent were seasoned and 47 per cent were green.

These poles were shipped to Savannah and near-by points in Georgia, and were set in accordance with a plan which is so arranged that in practically every case a treated pole stands between a seasoned and a green pole. This insures for each kind of pole soil conditions as nearly identical as is possible to obtain in pole line construction. The setting plan is given on page 22.

Setting plan. Savannah-Abbeville-Eastman Toll Line.

[Poles from Wilmington and Pisgah, N. C.]

Pole No.	Preservative.	Condition.	Pole No.	Preservative.	Condition.
1	A		18		Seasoned.
2		Seasoned.	19	D	
3	A		20		Green.
4		Green.	21	E	
5	B		22		Seasoned.
6		Seasoned.	23	E	
7	B		24		Green.
8		Green.	25	F	
9	C		26		Seasoned.
10		Seasoned.	27	F	
11	C		28		Green.
12		Green.	29	G	
13	D		30		Seasoned.
14		Seasoned.	31	G	
15	D		32		Green.
16		Green.	33	G[a]	
17	D		34		Seasoned.

[a] Green poles treated with Preservative "G."

The series is repeated 24 times, series No. 2. beginning with pole No. 35, series No. 3 with pole No. 69, etc. There are 816 poles in the line.

Notes pertaining to the seasoning and treating of each pole, together with exact descriptions of the character, composition, and depth of the soil and subsoil, and general notes of the immediate locality and of the equipment of the line, were made. Every pole in the line was plainly marked with its number stamped upon a small zinc tag, which is nailed to it about 5 feet from the ground, and also with large painted figures. To insure absolute certainty of finding every pole when the line is inspected in subsequent years, the numbers assigned to the experimental poles by the telephone company, when the line is stenciled from end to end, are also recorded. The line will be inspected from time to time, and notes of the condition of each pole recorded on the reverse side of the sheet containing its seasoning, treating, and setting records.

WARREN-BUFFALO LINE.

Arrangements were made with the American Telephone and Telegraph Company to set the treated and air-seasoned poles from Dover, N. J.,[a] and Thorndale, Pa., together with a number of green poles, in a portion of the line between Warren, Pa., and Buffalo, N. Y. This line runs through a varied country, and all types of locality from high, rocky ridges to low, mucky swamps are represented in the 60 miles through which the experimental poles are set. Because of this diversity of soil character and composition, an excellent opportunity to study the effect of various soils on the life of timber is afforded, and it is hoped that valuable results will be obtained.

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[a] Because of a misunderstanding with the construction company the Dover poles were not set by the plan. They are, however, carefully numbered and will afford valuable data, which will be used in conjunction with that obtained from the Thorndale poles.

The experimental poles are set according to a plan similar to that used in Georgia, and notes were made and poles numbered in the same manner.

Setting plan, Warren-Buffalo line.

[Poles from Thorndale, Pa.]

Pole No.	Preservative.	Condition.	Pole No.	Preservative.	Condition.
1	A		18		Seasoned.
2		Seasoned.	19	E	
3	A		20		Green.
4		Green.	21	D 1[a]	
5	B		22		Seasoned.
6		Seasoned.	23	D 1[a]	
7	B		24		Green.
8		Green.	25	F	
9	D		26		Seasoned.
10		Seasoned.	27	F	
11	D		28		Green.
12		Green.	29	G	
13	D 1[a]		30		Seasoned.
14		Seasoned.	31	G	
15	D 1[a]		32		Green.
16		Green.	33	D 2[b]	
17	E		34		Seasoned.

[a] D 1, Preservative "D" applied to poles by the open-tank process.
[b] D 2, Preservative "D" applied to green poles by the open-tank process.

The series is repeated 24 times, series No. 2 beginning with pole No. 35, series No. 3 with pole No. 69, etc. There are 816 poles in this part of the line.

Because of the care with which all details of the seasoning, treating, and setting of each pole in the two lines have been noted, and of the variety of treatments, the diversity of the country, and the distance for which the lines run, the results obtained from the experiment should be invaluable in determining many points now in dispute as to the length of service of timber in contact with the ground, and should add much to our knowledge of the seasoning and treatment of timber in this country.

Approved:
JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *May 9, 1907.*

OTHER PUBLICATIONS OF THE FOREST SERVICE WHICH DEAL WITH WOOD PRESERVATION.

Bulletin 10. Timber: An Elementary Discussion of the Characteristics and Properties of Wood. (Securable only by purchase from the Superintendent of Documents, Government Printing Office, Washington, D. C. Price, 10 cents.)
Bulletin 41. Seasoning of Timber.
Bulletin 50. Cross-Tie Forms and Rail Fastenings, with Special Reference to Treated Timbers.
Bulletin 51. Report on the Condition of Treated Timbers Laid in Texas, February, 1902.
Circular 39. Experiments on the Strength of Treated Timber.
Circular 80. Fractional Distillation of Coal-Tar Creosote.
Circular 98. Quantity and Character of Creosote in Well-Preserved Timbers.
Circular 101. The Open-Tank Method for the Treatment of Timber.
Circular 103. Seasoning of Telephone and Telegraph Poles.
Extract 395 from the Yearbook of the Department of Agriculture (1905): Prolonging the Life of Telephone Poles.

[Cir. 104]

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